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ABSTRACT

A justification for the study of teachers' routines, as they affect the preparation of lesson plans, prefaces this paper on teachers' thought processes during lesson planning. In focusing on the importance of research into teachers' routines, it is pointed out that lesson preparation and classroom routines permit teachers to direct attention to special difficulties encountered by students. It is noted that routines also provide clues to teachers' information processing methods and to teachers' ways of solving problems. The nature of routine activities and the sequential steps followed by teachers in making lesson plans and classroom decisions are considered along with psychological studies in this area. A report is presented of a study of teachers' perceptions of their lesson planning and routine planning activities. Questions addressed involved: (1) classroom issues or problems that teachers treat in the classroom and that do not require planning; (2) classroom issues or problems that are factually treated or at least mentioned during lesson planning; and (3) classroom issues or problems that are considered during lesson planning. In an analysis of the study's results, it is noted that experienced teachers differed from novice teachers in that their knowledge permitted them to predict classroom conditions and execute lesson plans in one step rather than in a series of sequential decisions. (JD)

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HOW TO ANALYZE ROUTINES IN TEACHERS' THINKING PROCESSES DURING LESSON PLANNING

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How to Analyze Routines in Teachers' Thinking Processes During Lesson Planning

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1. Why investigate routines?

The following describes "routines" in teacher activity, and the problems of investigating them empirically. Also a study on routines in teacher planning is presented.

As an introduction, there is a survey as to the aspects under which studying routines can be of interest at all.

- "Routines" are an important object of research, because they are of practical importance for teaching and teacher education, and because they have hitherto been sparsely treated in research on teachers' information processing and instructional behaviour.

- Routines in lesson preparing and in the classroom are apt to reduce the cognitive effort required of the teacher. They permit him to direct his attention to special difficulties or to conscious improvement of his teaching. This is an idea already apparent in models about the development of teachers competence (Fuller 1979). Insofar, they are a prerequisite for all innovations of the school system which use teacher activity as their starting point (this aspect is the most frequently named in the rather spurious literature).

- Classroom routines increase the stability of teacher behaviour and thus its predictability for the student (Clark & Yinger 1980). The predictability of teacher behaviour, again, belongs to the variables which influence (in an intermediate way by means of student behaviour variables such as active use of learning time) the academic improvement of students.

- But teacher routines can also have negative effects; this also raises the question of whether they can be changed, and how (see Hoetker & Ahlbrand 1969);
- "Routines" are an important object of teacher education. In recent years, there have been rather positive opinions on routines in textbooks on teacher education in West Germany (see Grell & Grell 1979, Meyer 1980, Bromme & Seeger 1979).

There are practical reasons in favour of empirical and theoretical research on routines. Besides, routines are an interesting object for the fundamental research of cognitive psychology which studies problem solving in the case of complex problems, whilst, in doing so, tries to describe the differences between novices and experts. Routines are the very characteristic of the performances studied (for example in chess playing, computer programming, solving physical or geometrical problems etc.) which permits to distinguish between novices and experts.

Finally, routines are an important object of the research on information processing of teachers, as the hitherto existant data on pre-instructional as well as on instructional information processing of teachers that these processes do not take place as merely shows conscious problem solving with rational choices of behavioral

alternatives. A fact which requires that the theoretical conceptualization of "teaching as problem solving" must be modified in order to do justice to the importance of routines in theory development as well.

We shall now give a brief description of a study (Bromme 1981) concerned with the question as to how far thinking in daily lesson planning can be characterized as problem solving, and to what extent the description must draw on other concepts than those of the problem solving approach.

2. Problem Solving in Lesson Planning: Some Results of a Study Using the Thinking Aloud Method.

The study's starting point was the assumption that running a routine vs. problem solving were the two alternative modes of coping with a demand on the information processing system. The empirical question now was, which components (parts) of the lesson planning process "run" in which mode. Newell and Simon (1972) have shown strategies of problem solving by means of the General Problem Solver model, which consists of steps by which the data base of the problem solving system will be transformed from one state into the next one. These steps described by Newell and Simon and their successors (and which are the components of strategies of the GPS system like working forward and working backward), are similar to the basic steps of problem solving already described by J. Dewey: establishing the initial conditions, identifying the problem dilemma or the difference between starting point and goal, producing hypotheses, selecting hypotheses, etc..

Our own hypothesis now, was: if lesson planning is done in the mode of problem solving, a comparable sequence of those steps ought to be identifiable. In order to ascertain this, the daily lesson preparing(1) of 14 mathematics teachers was recorded once per teacher with the thinking aloud method, and transcribed. These protocols were then dissected into units approximately corresponding to a phrase each. Each of these units was then coded several times, i.e. with a system of content analysis, a system used to examine implicit relations between the units, and a so-called basic coding. These basic categories are of interest here, as they had been formulated according to the elementary steps of the problem-solving process which we have mentioned above:

1. Stating an issue,
2. naming a question/ a difficulty to be overcome,
3. hypotheses, alternative solutions,
4. solution/ selecting an alternative,
5. expecting/ anticipating a result.

This basic coding was carried out by two coders, and the distribution of categories across the course taken by lesson planning was established. Besides, the planning steps have been described by using a simple Markov model. The transition probability of one step to the next was calculated in order to establish the sequential dependency of certain steps occurring. In order to check our hypothesis, a sequence of steps expected for problem solving (taken from a study on problem solving in proving logical theorems, see Luer 1973) was compared to the empirically established one. On the basis of transition probabilities of the third order, that is of step sequences having at least three elements, the cautious estimate is that only 3 percent of the course taken by planning corresponds to the pattern of problem solving.

Planning, to a large part, takes place by collecting information about the conditions given in the lesson, and as deciding on certain steps to be taken by the teacher without deliberating options. This is also evident from the distribution of the frequencies with which the above mentioned steps of problem solving occur (see table 1).

This, however, does not mean that planning has to be considered merely as "running " a fixed program. Indeed, a total of 10 percent of all units were coded as "naming a question/ a difficulty to be overcome" (see table 1). The transition, however, from such a mentioned problem to decisions is immediate and abrupt.

It is interesting that there is a statistically significant positive relation between the professional experience of teachers and the amount of statements made about the conditions prevailing for the lesson (Spearman rank correlation) = .5 (sign 5%), and there is an inverse relationship between professional experience and the frequency with which other options were taken into account. This indicates that the preference shown for statements about given facts of the classroom world and immediate transition to decisions about what has to take place in the classroom may be interpreted as characteristics of routinization. It ist not appropriate to enter into this at any length here. It shows, however, that the teacher, on the one hand, perceives some degree of freedom for his decisions in lesson preparing, but that these decisions will result directly from considering the situation given. In this sense, we can speak - with some exceptions - of a routinized process. This is true as well, even if the entire course taken by planning is considered instead of just analyzing the local sequence characteristics by means of a Markov analysis. (This is of further interest because the prescriptive model of teacher education in the German Federal Republic rather corresponds to the problem solving idea. Accordingly, it would be necessary to comprehensively analyze the conditions of the lesson, consider the options, and then make decisions. In fact, however, there is a sequence of decisions which mostly refer to mathematical tasks for pupils, and to their selection. Decisions are made by selecting these tasks, and they refer to them. Hence, there are no individual, separate stages of analyzing curriculum, student characteristics, and previous knowledge etc., but these questions are decided, respectively, by selecting tasks and by anticipating their treatment in the classroom.)

These results strongly correspond to those reported by Clark & Yinger (1979, 1980) and Shavelson & Stern (1981). The concept of "task", however, has a more restricted meaning: it refers mainly to the mathematical task selected by the teacher, this decision of selection being a process within which the other aspects are considered as well. From this, we draw the conclusion that the problem of the logical structure of the curriculum, and the resulting degrees of freedom to organize student activities, plays an important part in teachers' thinking, and that, consequently, real attention must be given to the effects this subject matter structure has on the thinking process.

3. On the Procedural Description of Routines

The intention of this section is to define the concept of "routines" more precisely. A distinction must be made between routines in planning, and routines in the classroom. Lesson planning can be done in a routinized way, i.e. routines will be part of lesson planning in case the teacher rapidly generates mathematical tasks referring to the

subject matter "intuitively", or selects them from mathematical textbooks.

The teacher's classroom routines, however, are of importance for planning as well, insofar as they represent an object of planning. They will be an object of planning, for instance, if the teacher, in lesson preparing, merely notes "discuss homework", and relies on his ability to generate the necessary behaviour in the classroom. (Yinger, 1978, has distinguished such "teaching routines" which combine, respectively, a complex bundle of the teacher's classroom behaviour.)

Besides the distinction between planning routines and classroom routines, a further distinction according to the mode of description is required: routines can be described with regard to their purpose resp. to the objective to be attained, and they can be described as a process, as a component of behaviour or thinking. In the following, describing the purpose, and hence the content of routines, will be called the declarative mode of description, and describing the behaviour and thinking components belonging to routines will be called the procedural one.

The majority of "routines" in connection with lesson planning is described in the declarative mode, i.e. their effect and content are described. Yinger's (1979, 1980) description of teaching routines is a declarative one. Content analyses of planning notes or thinking aloud protocols will also yield a declarative description of planning routines. For a declarative description, the researcher will mainly require educational/ pedagogical concepts. As opposed to that, the concepts required by a procedural description will be mainly psychological. Research into teacher cognitions, however, up to now, has yielded rather more declarative than procedural descriptions.

An important problem of procedural description is the question which modifications will result from the idea of the "teacher as a problem solver". Yinger (1978) for instance, uses results obtained from studying the design process of architects, artists, etc. for a procedural description of thinking while planning, and we have proposed to draw on concepts taken from psychological research on understanding of texts (Bromme 1981a).

There are, consequently, the following specifications of the concept of routines:

	procedural description	declarative description
planning routines	A	B
teaching routines	C	D

It follows from the above, that A and B are important for studying planning routines, as well as D, as teaching routines can well be the object of planning, [illegible] have to be described in a declarative mode at least. C is of interest if the effect of planning on teaching is to be studied - an issue which will be omitted here.

Especially the procedural description of routines is difficult; this seems to be the reason why declarative descriptions of the content and effect of routines prevail in the field of research on teacher cognitions. Procedural description of routines in lesson planning,

however, is made difficult by the fact that psychological theory about routines is mainly developed on the basis of activities having a strong behavioral motor component, or on the basis of rather simple and basic perceptual processes in search-detection-tasks such as those used by Schneider & Shiffrin (1977).

As the focus of psychological research on routines resp. automatised behaviour is mostly on rather simple behaviour (the research problems obviously being difficult enough), use of the "routine" concept is more based on experience with automatisms found in everyday life. This seems to be true for cognitive psychology as well. Cf., for instance, Simon (1979, 388): "Everyday experience has suggested another idea to modelers of the cognitve system. Processes continue to speed up gradually over long periods with practice. At the same time, they come to require much less conscious attention and become less accessible to conscious awareness (...)" (italics by us).

A psychological, procedural description of routinized activities supposes at least two processing levels: a control level and an executing level. Routinization assures that executive steps can be made without control by "higher" levels. Driving a car, for instance, is considered a paradigmatic example of routinized activity, or one in which a host of information must be processed and in part transformed into the driver's motor behaviour without conscious control.

Both in the designs of psychological research into routines of the kind mentioned above, and in everyday conceptions of routinized activities, the executive steps thus consist of simple detection or search processes, or of motor behaviour. This is a significant difference to the executive steps in lesson preparing, in which symbolically codified, abstract semantical information must be processed. Thus, for instance, the teacher reads his/ her own notes, looks things up in textbooks in order to select mathematical tasks, and he/ she has to integrate the so-called semantic knowledge into his/her teaching experience, his/ her so-called episodic knowledge.

This processed information concerns, for instance, the subject matter structure (mathematical proofs, grammatical rules, etc.), marks given for student performance, test results, etc., that is, information which is rather abstract, and codified by means of linguistic and mathematical symbols.

The processing of such information has been studied primarily in the field of psychological research on text understanding and on problem solving within semantically rich domains. This latter field of research also includes several studies on the differences especially within this problem-solving approach. Differences between novices' and experts' performances are reported in (Larkin et al(1980), and Chi et al(1981).

Most of these studies are concerned with modelling problem solving during work on physics and mathematics tasks taken from high-school textbooks. Of course, such approaches and results cannot be immediately transferred to our problem of teacher routines. (The problems of such transfers to the research on teacher cognitions will not be discussed here, just as a systematical survey of results on expert performances in problem solving will not be dealt with, due to lack of space).

As the executive steps studied in this approach are rather more

similar to the routines in planning than the activities mentioned above (i.e. driving a car), the question is, which consequences in favour of a procedural description of the planning routines will result from these studies.

Two of the results of these studies are of particular interest for studying teachers' planning routines:

- Problem-solving by experts tends to be done more in a forward-working style, while novices tend to focus on the unknown variable sought, a fact which confers a more backward-going character to their search. This coincides with the results on thinking while lesson preparing. Several authors have reported that the teacher's objectives apparently do not play as important a role as assigned to them in prescriptive models of teacher planning (cf. Yinger, 1978, Morine 1976,). This fits in with the forward working style in the problem-solving of experts. Both, of course, are not cases of an unstructured activity. Rather, there is, in physics experts as well as in teachers, a structure of knowledge which can be activated by a few cues and which leads to a conceptualization of the open questions resp. planning dilemmas. Thus relative neglect of objectives could possibly be interpreted as the result of a forward strategy within which a focus on goals or objectives would not be functional.

- Experts, as opposed to novices, have more field-specific knowledge on the conditions of application of the relevant rules, principles, etc., at their disposal than novices. The knowledge about the conditions of application is integrated with the relevant rules in such a way, as to assure that those elements of the problem situations will be perceived, for which the expert possesses the knowledge required for further treatment. Then, a few cues from the problem situation will suffice to activate the very knowledge required for further search within the problem space.

Roughly speaking, the basic idea of this approach worth noting, says that experts have an integrated knowledge in which knowledge about the conditions of applying rules and the rules themselves are linked, a fact permitting a rather rapid speed in solving tasks.

It is important to see that psychological models of the organization of knowledge are developed for a procedural description of experts' routines within this research approach.

This is a significant difference as compared to the items about routines which have been developed within research approaches about automatized processes or to the everyday life conceptions of routines mentioned above. While these approaches stress the independence of the executive steps from the control level, which reduces the cognitive load and thus permits higher speeds, the problem-solving approach tends to consider the reduction of cognitive load as due to an appropriate organization of knowledge (which is simulated as production system). Of course, there is no genuine contradiction between the two approaches in the sense of alternative or competing hypotheses (as the problem of control structures and of organization of knowledge must be solved within the two approaches, and is, in fact, solved in the instance of simulating by means of computer programs). The transfer of such ideas to our field of application, however, requires that such differences be made evident, as they will lead to recommendations with regard to "directions of search" for the

effort to achieve a procedural description of planning routines, and to indications as to which ideas of cognitive psychology can be used here.

The recommendation for further research into teacher routines thus, is, that it should focus on describing the organization of knowledge in memory (short-term, and long-term memory) empirically and theoretically. (The concept of "routine" may not be so well suited at all, as it first of all implies the absence of conscious control. The concept of "cognitive skills" might be more appropriate, c.f. Anderson 1981).

4. The Accessibility of Knowledge Used in Routines

In the psychological research on memory, on text understanding, as well as in the ethnomethodological approach in sociology, there is a fundamental distinction between the knowledge situated in the focus of a reader's, problem solver's etc. attention, and the knowledge which concerns the context of these activities and which is important for the respective performance, but is not situated in the focus of attention. This fact is also reported in studies on lesson planning.

Various studies yield the following picture: the focus is on decisions on tasks, on students' and teachers' classroom activities which must be adapted to available materials, to the subject matter to be taught, and to the students' previous knowledge (cf. Clark&Yinger 1979, Shavelson & Stern 1981).

At the same time, there are frames or conditions of these planning issues which are in the focus of the teacher's awareness. These conditions are, for example: the decision about the curriculum which results from the teacher's or school's planning for the year or term, the global goals of schooling teachers (including their basic philosophy as to the meaning of school etc.), the teachers repertoire of classroom routines, his/ her perception of the organizational prerequisites of teaching. (The consistency of the results, however, is dissatisfying. Of course, this is partly due to the question on which issues the teachers place the focus of attention while planning and which ones they merely consider as conditions or frames. This depends on subject matter, grade, and school type.

It is mainly due to this focus vs. frame problem that Shavelson & Stern (1961), amongst others, speak of scripts and schemata in connection with planning and teaching routines.

Now the distinction between explict, conscious knowledge in the foreground and knowledge describing the frame or context of such foreground knowledge is a fundamental idea developed by the constructivistic theories of memory. The concept of "schema" or "script", however, which is widely used as an elaboration of this idea, only names the problem, but does not yet provide a procedural description of planning routines.

Above all, this also raises a difficult methodological problem: background knowledge can, in part, only be explained by means of deliberate questioning. On the other hand, such deliberate questioning could lead to the elaboration of additional considerations which play no proper role in planning under natural conditions. This issue is at the core of the methodological debate about the accessability of action relevant cognitions (cf. the Nisbett and Wilson controversy,

e.g. its review in Ericsson & Simon 1980, or in Huber & Mandel 1980).

How can it be assured that the data gathered about thinking does concern the knowledge really relevant for planning decisions?

- It is certainly of importance that rather weak methods of data collection are used, such as the thinking aloud method, semi-structured interviews, etc., as the conceptualizations chosen by the teacher for his considerations permits inferences on implicit consideration of framing conditions. Methods have therefore been developed especially in the field of psycholinguistic research, cf. e.g. Tannen, 1979).

  The methods of collecting data shall not be treated in detail here; the above mentioned contributions to the Nisbett & Wilson controversy contain many indications to that topic.

- Furthermore, it is important not to concentrate only on cognitions and verbal data, but to link these data about teacher cognitions to a theoretical and - if possible - even empirical analysis of the professional demands the teachers have to cope with. In other words: if the information processing to be studied occurs both conceptually driven and data-driven - a fact which evidently results from the perspective of constructivist theories of memory - the analysis of knowledge organization will only be possible if the "data"-side is analyzed as well. These "data" for the teacher are the professional demands adressed to him which result from his teaching subject, from the grade, from the school's implicit and explicit rules, its organzation, etc. Now professional demands cannot be studied as such, as they take effect only because, and so far as, they are perceived. This is why this does not contain the fundamental key to the problem described above, but is a useful heuristics for research into routines. The idea is that the researchers must always relate their analysis of professional demands and their analysis of verbal data about teacher cognitions to one another.

- Finally, the teachers themselves can be questioned as to which facts of the classroom world they consider at which point in time, whether they think of them to be framing conditions of planning and teaching. Answers to such questions are of interest mainly if they can be combined with data obtained by means of a process tracing method. This was how we have proceeded in the study which will be reported in the next section.

5. Which Parts of Planning Teachers Perceive as Routinized. A Study of Teachers' Perception of Their Own Lesson Planning.

Problem:
The above considerations about routines lead to the following questions:

A) Which issues of classroom reality does the teacher consider as to be treated in the classroom, or as self-evident and thus not requiring any planning?
B) Which issues of classroom reality are factually treated or at least mentioned during lesson planning?
C) Which issues are perceived as treated during lesson planning by the teacher?

Method:
The study was carried out subsequent to the investigation of the planning process by means of the thinking aloud method described above (cf. section 2). After thinking aloud had been recorded, the teachers were asked, with regard to 21 items, how they had taken the respective issue described in an item into consideration in the lesson planning they had just completed, or in which way they intended to make allowance for it (See table 2 for the 21 planning issues). Each item was presented on a card, and the teachers were asked to mark one of the following 6 response alternatives (the order of presentation being varied):

1. I should have considered this issue (for instance, the seating order) in the lesson planning I have done just now;
2. I shall consider it before the next lesson;
3. I am used to deciding that in the classroom, whilst the lesson is going on;
4. This issue is self-evident and I don't have to consider it extensively, neither in lesson preparing, nor in the classroom;
5. This issue is of no importance for the lesson just prepared;
6. I have considered this issue just now while planning.

1 and 2 were meant to cover those issues the teacher had just overlooked in this particular case of planning, but generally considered to be important for a conscious, not routinized decision. 5 covers those issues which are, in the view of the teacher, so irrelevant as not to merit further interpretation during planning.

Results:
On the whole, the items selected concern issues which, in the view of the respondent teachers, are important for lesson planning and/or instruction. Only 17 percent of all selections concerned items 1, 2, and 5 (the total being 294 = 100 percent, or all selections).

This means, that the issues - necessarily selected by us a priori from the classroom world - are in fact considered relevant by the teachers.

To Question A

The issues the teachers questioned to consider as to be dealt with within the classroom, or as self-evident anyhow and not requiring any planning, follow from the response alternatives 3 or 4. 13 out of 14 teachers regard the seating order (No 1) as something not to be

considered in planning. Changing the seating order is thus not seen as a means of changing the way teaching is done (an opinion which may be due to the fact that most respondents teach grades 6 to 11).

Beyond that, there are no items scored as given (in the sense of response alternative No 4) by a majority of respondents. Five teachers, respectively, consider the school's subject matter distribution plan (No 3) or the teaching/ learning objectives (No 21) as a given condition of instruction. A pattern comparison of the answers to these two items shows that - taken together - they were given by nine teachers, a fact from which we conclude that both answers refer to a perception of the curricular frame which is only implicitly taken into account by the teachers. We shall dwell on this below.

What is to be done about student problems in the classroom is a matter the majority of teachers do not consider necessary to be treated in planning, but to be decided in the classroom. This is not only true for problems of discipline (No 13) - as was to be expected - but also for students having special difficulties with the subject (No 12). Only with regard to student problems is there such a significant tendency to decide on teacher action in the classroom. This is remarkable as we asked about the planning of activities, and not how activities were to be assigned to individual students.

To Question B

The issues actually mentioned in planning were found out from the thinking aloud transcripts. Besides, it was possible to draw on the results of the content analysis contained in the above mentioned study (see section 2). Thus, one of the results of the content analysis carried out in the frame of the main study mentioned was, that the focus of lesson planning is on selecting mathematical tasks and on anticipating their treatment in the classroom.

The issues from the item list which were indeed mentioned by the majority of teachers show, again, which criteria are taken into consideration by teachers when selecting tasks. (The results of coding the factually mentioned items are shown in column FM of table 2. Because of the small number of teachers, the raw data are given in absolute numbers, and not in percent).

A cluster analysis was carried out (2) in order to group all those items which were actually mentioned together by several teachers (see table 3). Cluster (a) is trivial, it contains all the issues hardly mentioned or not mentioned at all. Among them are students showing discipline problems (No 13), the anticipated students' speed of understanding (No 16) as well as the syllabus and the schools subject-matter-distribution plan (No 3).

Cluster (b), however, contains the issues which are important for selecting tasks and anticipating classroom activities. At least one third of teachers, respectively, mention the mathematical constraints on the sequencing of the subject matter (No 2), and the use of examples (No 10).

It is interesting to note that there is, in some teachers, a focus on the rather subject-matter-oriented criteria combined in (cluster b 1), whilst the more practical ways of dealing with tasks, such as students' exercising (No 7) and use of the blackboard (14) appear together in the focus of other teachers (cluster b 2).

Task selection is also the concern of the introductory phase (No 9), and of planning the homework (No 9). Beyond this cluster, there are three further issues mentioned by at least half of the respondents, i.e. the previous knowledge about the subject matter (No 18), the classroom organization of students' work (No 6), and the teaching/learning objectives (No 21).

To Question C

The frequency of appearance of the differences between perceived and factually mentioned planning issues varies greatly throughout the items. Table 4 illustrates this by means of a histogram.

It is seen that the issues on which most teachers' planning focuses are also validly perceived as having been mentioned - as has been explained above. There is a difference only in the case of one item within the cluster (b) containing the most important issues of planning (see above): almost all respondents perceived having planned the introductory phase of the lesson, among them also those three who did not explicitly do so. Preparing the introductory phase (item No 8) thus, is the planning issue considered by the greatest number of respondents as a planning task.

There is also precise recall, obviously with regard to issues hardly not mentioned or not mentioned at all. Non-mention during planning was based on a stable attitude that this was either an issue unimportant for the next lesson (such as giving marks to students), or an issue to be treated ad hoc in the lesson, but not in planning (see the results to question A above).

Rather large differences with regard to the sum of actual and perceived mentions are evident in the case of student characteristics. Thus, 10 of the 14 teachers state to have made allowance for the student's speed of understanding (No 16), but have not actually mentioned it. To a less extent, this discrepancy is also present with regard to the question how the teachers intend to increase students' active involvement (No 11). 11 teachers pretend to have taken into consideration students' previous knowledge about the subject matter (No 18) during planning, but only 7 have actually mentioned it. There is a further discrepancy with regard to the presumable interest in the subject matter. It was actually mentioned only four times, but 7 teachers stated to have considered it.

11 teachers state that they have taken into account the temporal frame, i.e. the relationship between subject matter and time available (No 20), but only 4 have explicitly treated it in planning. This fits in with the above mentioned difference in the matter of the students' speed of understanding, as this speed will determine, to a large extent, how fast the units of the curriculum can be treated.

There are only two items with large discrepancies which do not concern the students, i.e. the governmental mathematics syllabus (No 4), and the school's subject-matter-distribution plan (No 2). (the latter being a special version of the former established by the school's staff conference).

Discussion:
The differences between factual and perceived mention of the syllabus (be it a governmental or school-specific one) - named last - are comparable to the effect of yearly planning and term planning described by Yinger (1978)

The research results concerning the importance of student characteristics for the planning process, as far as we know, are somewhat contradictory (c.f. Shavelson & Stern 1981). Our study can contribute the following to this question:
- the external, observable student activities, and especially those to be initiated by the teacher, are explicitly mentioned;
- the prerequisites and objectives of such activities such as previous knowledge or speed of understanding are less frequently treated in planning, but taken into account;
- issues concerning the difficulties encountered by some students are neither explicitly nor implicitly taken into consideration in planning;

This result, however, raises the question of how teachers make allowance for the variability of student abilities and involvement, as the above planning decisions are very well affected by them. A possible explanation is that planning is implicitly made only for a section of the student population, and that the required compensatory or remedial action for the students not belonging to that section is actually decided upon ad hoc in the classroom. Just as there is, obviously, a steering group in the classroom(i.e. the group of students the teacher preferably interacts with,c.f.Lundgreen 1972), there might be something like it in planning. In my opinion, this seems to be an important question for further research on planning.

Which indications do these results provide for the problem of procedural description of routines?

If we use the idea of the condition-action unit known from the above mentioned research on procedural knowledge and its use by experts, the explicitly made planning decisions can be regarded as actions. These decisions are made dependent of conditions, which can be summed up as follows: in thinking aloud, it is mostly the textbook and the mathematical constraints on the sequencing which are explicitly considered as a condition of decisions, most decisions however, being made without mention of the conditions (see, for this purpose, in table 1 above the difference between the frequency of stating a fact (23 percent) versus selecting an alternative (49 percent).

If teachers, however, are asked which of the planning issues mentioned

they have perceived, the list of these conditions is extended (by conditions such as available time and students' learning speed, as described above). Now why are the teachers - partly - convinced of having mentioned these conditions? (3)

A possible explanation, is that the meaning of the concepts they use has extended in the course of their professional development. We have no systematical data on this matter, but indications provided by interviews held with the teachers participating in this study. According to these, selecting examples, for instance, is of crucial importance for teachers' decision on mathematical tasks. This selection is accompanied by expectations of an effect on students' motivation and understanding, which goes far beyond that which is associated with use of examples in instructional theories.

Similar explanations are possible for teachers' assessing the time students require to cope with a task. Possibly, certain working forms are associated with immediate experience about the time required for dealing with a task within a certain working form.

Such an interpretation of the differences observed between perceived and actually mentioned planning issues thus leads to an indication as to how teaching routines must be examined: the words teachers use when thinking aloud, or in other modes of verbalization, must not be simply taken literally, or in an everyday sense, but must be examined as to their potentially changed extensional meaning.

In other words: in section 3 above we have reported that experts are distinguished from novices in that their knowledge is so highly integrated as to permit testing conditions and executing actions in one step. This integration of knowledge - and this is our hypotheses - can be found again in the extended meanings the teachers attach to concepts which they use in thinking aloud.

This is only a speculation to conclude. If it should turn out to be correct, it will result in an indication as to the connection between various traditions in the study of teacher cognitions, that is between the more ethnomethodological traditions which have always raised the question of the subjective meaning of the concepts teachers use, and the tradition of the psychology of problem-solving which has shown the significance of the organization of knowledge in experts.

Notes

(1)The teachers taught grades 6 to 11,x of teaching experience was 10.- years,SD was 8.54 years.

(2) Of course, cluster analyses imply subjective decisions made by the researcher with regard to the underlying measure of distance or similarity, and the algorithm of clustering. In this case, Euklidean distances for binary variables were used as a measure of distance (simple matching principle, i.e. the relative proportion of nonidentical answers), and the single linkage method (which forms groups according to the greatest similarity of two group members) was used as fusion method. It must be noted here that there may occur a chaining effect by this method which makes clusters remain interconnected by meaningless links. The program package used was 'Clustan', Wishart (1978).

I am grateful to Wolfgang Barz for his help with the cluster analysis.

(3) One might object that these discrepancies are simply an artifact of the method applied: during thinking aloud, one just does not explain everything present in the head of the problem solver. This objection is certainly valid. It does not mean, however, that there is no sense in raising the question whether there are psychological and task-specific reasons explaning why some things are verbalized, and others are not.

Table 1+

"Modes" of thinking during lesson planning (N = 14 teachers)

Basic categories to code planning steps	$\bar{x}$ (abs.) $\bar{x}$ (%)	SD[1] of %
(1) stating an issue/fact	40.7 23 %	6.03
(2) naming a question/a difference of starting point and goal	17.8 10 %	2.57
(3) production of hypotheses/ of alternative solutions	13.7 8 %	3.73
(4) solution/selecting an alternative	87.2 49 %	6.8
(5) expecting/anticipating a result	6.9 4 %	2.77
(6) self instruction/ comments on the process	11.1 6 %	3.56

1) Because of interindividually different protocol lengths SDs are calculated on the basis of the relative amount of categories assigned to each protocol.

+ from Bromme (1981, 130)

Table 2

Perceived moment of decisions on 21 planning issues (N=14 teachers).

FM=Factually mentioned during planning; 1-6 see page 9		1	2	3	4	5	6	F M
1	students' seating order				11	3		1
2	mathematical constraints on the sequencing of the lessons subject matter				2	1	11	10
3	schools' subject matter-distribution plan	1			5	1	7	
4	governmental mathematics-syllabus for this grade				4	2	8	2
5	how to evaluate and mark students during this lesson	1		4	3	6		
6	classroom organization of students' work; i.e. if there is to be individual work, teamwork etc.			4	2		8	9
7	students' exercising				2	3	9	9
8	introductory phase of the lesson			1		1	12	9
9	homework for the next lesson			4		2	8	9
10	use of examples for teaching			1	1	2	10	10
11	how to increase active involvement of pupils during the lesson			1	2		11	5
12	what to do with students who will run into special difficulties with the subject matter			9	1	1	3	5
13	what to do with students showing particular problems of discipline			8		6		
14	blackboard-use for teaching		1	3	1		9	11
15	textbook-use in the classroom		1	2		5	6	3
16	students' speed of understanding mathematical subject matter			2	2		10	
17	presumable interest of students in the subject matter of the lesson	4			3		7	4
18	how to allow for the previous knowledge about the subject matter which might be present in the students	1	2				11	7
19	mathematical operations to be learned by the students	2			1	1	10	8
20	temporal frame i.e. the relationship between subject matter and time available			1	2		11	4
21	teaching/learning objectives for the next lesson	2	1		5		6	7
	$\sum$ (abs.)	11	5	40	47	34	157	113
	$\sum$ %	3.7%	1.7%	13.6%	15.9%	11.5%	53.4%	38.4%

Table 3
Cluster analysis of factually mentioned planning issues of 14 teachers.
(simple matching;single linkage method)

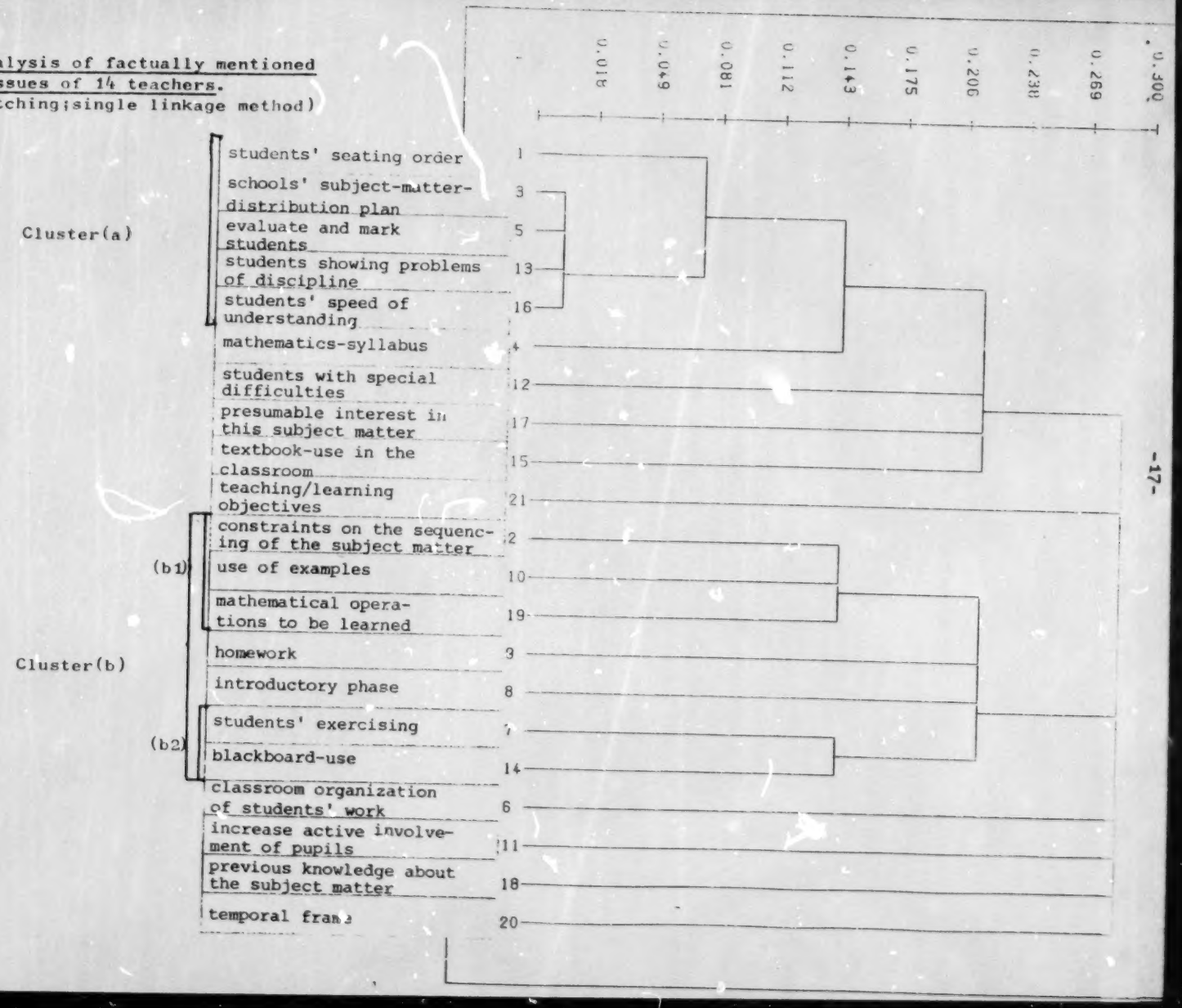

Table 4

Perceived (P) vs. factually (F) mentioned planning issues (N = 14 teachers)

14	blackboard-use	FFFFFFFFFFF PPPPPPPPPP
10	use of examples	FFFFFFFFFF PPPPPPPPPP
2	constraints on the sequencing of the subject matter	FFFFFFFFFF PPPPPPPPPPP
8	introductory phase	FFFFFFFFF PPPPPPPPPPPP
7	student's exercising	FFFFFFFFF PPPPPPPPP
6	classroom organization of student's work	FFFFFFFFF PPPPPPPP
9	homework	FFF FFFFF PPPPPPP
19	mathematical operations to be learned	FFFFFFFF PPPPPPPPPP
21	teaching/learning objectives	FFFFFFF PPPPPP
18	previous knowledge about the subject matter	FFFFFFF PPPPPPPPPPP
12	students with special difficulties	FFFFF PPP
11	increase active involvement of pupils	FFFFF PPPPPPP PPP
17	presumable interest in this subject matter	FFFF PPPPPPP
20	temporal frame	FFFF PPPPPPP PP
15	textbook-use in the classroom	FFF PPPPPP
4	mathematics-syllabus	FF PPPPPPPP
1	student's seating order	F
16	student's speed of understanding	PPPPPPPPPP
3	schools' subject-matter-distribution plan	PPPPPPP
13	students showing problems of discipline	
5	evaluate and mark students	

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